

# TITLE OF THE INVENTION

Fuel cell control system

## BACKGROUND OF THE INVENTION

5           This invention relates to a fuel cell control system for efficient operations of a fuel cell system.

          A fuel cell system disclosed in Japanese Laid-open Patent Publication No. 2002-63927 contains a means which increases a fuel to the fuel cell according to  
10       the increase of a circuit current between the fuel cell and a load and causes the secondary battery to charge to reduce the delay when an electric load increases.

          More peculiarly, this document discloses a method  
15       of controlling a fuel cell system by providing an auxiliary machine such as a gas pump, liquid pump, or control valve to actuate the fuel cell, supplying commercial power to the auxiliary machine or electric power from a fuel cell system to said auxiliary  
20       machine to supply hydrogen gas to the fuel cell, cool the fuel cell or control apparatus when a commercial power supply fails. With this, electric power to said auxiliary machine is supplied from a secondary battery connected to the fuel cell when a commercial power  
25       supply fails.

## SUMMARY OF THE INVENTION

An object of this invention is to provide an operation control system for a fuel cell that can detect electric power coming from an electric power system.

An object of this invention is to provide an operation control system for a fuel cell that can calculate a load power from the received electric power.

When the fuel cell system directly uses a load power and the load changes precipitously, the fuel supply to the fuel cell changes frequently. This reduces the efficiency of power generation of the fuel cell.

This invention improved operations of the system by causing the output of the fuel cell to follow the load, controlling the secondary battery to suppress the incoming electric power under a preset value, and using the fuel cell and the secondary battery efficiently.

This invention has a configuration below.

A fuel cell control system comprising a first converter electrically connected to an electric power system through a circuit-breaker means, a set of fuel cells connected to the DC circuit of said converter

through a second converter, a secondary battery  
connected to said DC circuit through a third converter,  
a current detecting means which detects AC currents  
from said converters and outputs their detected values,  
5 a voltage detecting means which detects an AC voltage  
on the power system side of said circuit breaker means  
and outputs its detected value, a fuel cell current  
detecting means which detects a current from said fuel  
cell set, a fuel cell voltage detecting means which  
10 detects the voltage of said fuel cell set, a secondary  
battery current detecting means which detects a  
current from said secondary battery, and a secondary  
battery voltage detecting means which detects the  
voltage of said secondary battery; wherein said  
15 electric power system is equipped with a receiving  
current detector which detects the total of a current  
flowing through said first converter and a current  
flowing through an electric load connected in parallel  
with said first converter.

20 A fuel cell control system comprising a first  
converter electrically connected to an electric power  
system through a circuit-breaker means, a set of fuel  
cells connected to the DC circuit of said converter  
through a second converter, a secondary battery  
25 connected to said DC circuit through a third converter,

a current detecting means which detects AC currents from said converters and outputs their detected values, a voltage detecting means which detects an AC voltage on the power system side of said circuit breaker means and outputs its detected value, a fuel cell current detecting means which detects a current from said fuel cell set, a fuel cell voltage detecting means which detects the voltage of said fuel cell set, a secondary battery current detecting means which detects a current from said secondary battery, and a secondary battery voltage detecting means which detects the voltage of said secondary battery.

The fuel cell control system further comprising a voltage regulating means which feeds back a DC voltage value detected by said first converter and outputs a current command value so that the product of the feedback DC voltage value by the current command value may be equal to the power command value, an automatic current regulator which feeds back said detected DC voltage value and outputs an output voltage command value to make the current equal to said current command value, a pulse output means which receives said output voltage command value and outputs pulses to drive the converter, and a control unit which controls charging and discharging of the power system

and power according to said voltage command value.

The fuel cell control system further comprising a means to control said second converter has a current control means to make the current command value to the  
5 current of the fuel cell and a means to control said third converter has a current control means to make the current command value to the current of the secondary battery.

The fuel cell control system further comprising a  
10 receiving current detector which detects the total of a current flowing through said first converter and a current flowing through an electric load connected in parallel with said first converter, a first power calculating means which calculates a receiving power  
15 from a receiving current detected by said receiving current detector and a system voltage detected by said system voltage detecting means, a second power calculating means which calculates a power from said first converter, and a means which calculates a power  
20 consumed by said load from the outputs of said first and second power calculating means.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a functional block diagram of a power  
25 converter which is one embodiment of this invention;

FIG. 2 is a functional block diagram of a converter controlling apparatus which is one embodiment of this invention;

FIG. 3 is a functional block diagram of a system  
5 current regulator of this invention;

FIG. 4 is a functional block diagram of an automatic current regulator of this invention;

FIG. 5 is a functional block diagram of an automatic current regulator of this invention;

10 FIG. 6 is a functional block diagram of a voltage regulator of this invention;

FIG. 7 is a functional block diagram of an automatic current regulator of this invention;

FIG. 8 is a functional block diagram of a power  
15 command value calculator which is one embodiment of this invention;

FIG. 9 is an explanatory figure for operation of the power command value calculator which is one embodiment of this invention;

20 FIG. 10 is a functional block diagram of a delay adder of this invention; and

FIG. 11 is an explanatory figure for operation of the fuel cell system control unit which is one embodiment of this invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Embodiments of the present invention will be described below with reference to the accompanying drawings.

5        FIG. 1 shows an embodiment to accomplish a power converter of this invention. FIG. 1 shows a single line diagram of a voltage type power converter which can convert a DC power to a single-phase AC power or a single-phase AC power to a DC power. Referring to FIG.  
10      1, a secondary battery Bat is connected to a DC/DC converter 1-1a which converts a DC voltage level. This DC/DC converter 1-1a is connected to a capacitor C1 (on the DC side) of the converter 1-1c which converts a DC power to an AC power. The AC output of said  
15      converter 1-1c is connected to a reactor L1 which constitutes an AC filter for removing harmonic components.

      The reactor L1 is connected to a circuit breaker BR1 and a capacitor C2 which constitutes the AC filter.  
20      The circuit breaker BR1 is connected to the power system 2. A load 3 is connected between the circuit breaker BR1 and the power system 2. The capacitor C1 on the DC side of the converter 1-1c is connected to the fuel cell through the DC/DC converter 1-1b. The  
25      fuel cell FC1 is connected to a pipe PP1. The pipe PP1

is connected to a fuel regulating valve VV1. The valve VV1 is connected to the pipe PP2 to regulate a flow rate of a fuel flow through the pipe PP1. The fuel cell FC1 takes in air and hydrogen-rich fuel which is reformed, for example, from a utility gas, chemically reacts the fuel gases into a DC electric power, and feeds the electric power to said DC/DC converter 1-1b.

The power regulator 4 (power control apparatus) receives a receiving current value IL1 detected by the current detector CT1 which is provided near the power system 2 between the power system 2 and the load 3, a voltage value VL1 detected by a voltage detecting means PT1 for detecting a voltage of the power system 2, and a second battery voltage value Ea detected by a secondary battery voltage detecting means. The power regulator 4 outputs a signal SVV1 indicating the opening of the fuel regulating valve VV1 to the fuel regulating valve VV1 and further outputs current command values IREFa and IREFb of said DC/DC converters 1-1a and 1-1b to the converter controlling apparatus 5.

The converter controlling apparatus 5 receives a current value Iinv detected by the current detector CT4 for detecting a current flowing through the reactor L1, a voltage value VL1 detected by the



voltage detector PT1, a voltage value  $E_c$  of the capacitor C1 provided on the DC side of the converter, a current value IBT detected by the current detecting means CT2 for detecting a current output from the secondary battery Bat, a current value IFC detected by the current detector CT3 of the fuel cell Bat, and current command values IREFa and IREFb of said DC/DC converters 1-1a and 1-1b. The converter controlling apparatus 5 outputs a gate signal GP0 for driving the converter 1-1c, a gate signal GPa for driving the DC/DC converter 1-1a, and a gate signal GPb for driving the DC/DC converter 1-1b.

FIG. 2 is a functional block diagram of a converter controlling apparatus 5 which is one embodiment of this invention.

Referring to FIG. 2 the voltage detector 6a receives said detected voltage value  $E_c$ , converts the level of the voltage value  $E_c$  to a preset voltage level  $E_{d0}$ , and outputs the voltage to the DC voltage regulator 7. The DC voltage regulator 7 consists of a proportion plus integration unit, calculates a current command value  $I_{sys}^*$  of the converter 1-1c so that the DC voltage command value may be equal to the detected DC voltage value  $E_{d0}$  (feedback voltage value), and outputs the current command value  $I_{sys}^*$  to the linkage

current regulator 8. The current detector 11 receives a current  $I_{inv}$  (feedback current value) from the converter CT4, converts the current into a current of a preset value  $I_{sys}$ , and outputs it to the linkage  
5 current regulator 8. The detected current value  $I_{inv}$  (feedback current value) is made equal to the current command value  $I_{sys}^*$ .

The phase detector 9 calculates a phase signal  $A_{sin}$  of amplitude "1" which follows the phase of the  
10 detected voltage value  $V_{L1}$  and an amplitude value  $V_{rms}$  of the system voltage, and outputs these to the system current regulator.

The current regulator 10b of the DC/DC converter 1-1b receives the current value  $I_{FC}$  from the fuel cell  
15  $F_{c1}$  and a current command value  $I_{REFb}$  from the power regulator 4 and outputs a pulse signal  $GP_b$  so that the current command value  $I_{REFb}$  may be equal to the detected current value  $I_{FC}$ .

Similarly, the current regulator 10a of the DC/DC  
20 converter 1-1a receives a detected current value  $I_{BT}$  from the secondary battery  $Bat$  and a current command value  $I_{REFa}$  from the power regulator 4 and outputs a pulse signal  $GP_a$  so that the current command value  $I_{REFa}$  may be equal to the detected current value  $I_{BT}$ .

25 FIG. 3 shows a functional block diagram of the

linkage current regulator 8.

Referring to FIG. 3, the multiplier Pr1 receives the current command value  $I_{sys}^*$  and the phase signal  $A_{sin}$ , multiplies these, and outputs a sinusoidal  
5 current command value  $I_a^*$  of an amplitude  $I_{sys}^*$ . As the phase signal  $A_{sin}$  is regulated to a sinusoidal wave which follows the "a" phase of the system voltage, the current command value  $I_a^*$  becomes a current command value of a power factor 1. The current command value  
10  $I_a^*$  is fed to the multiplier Pr2 and to the subtractor Def2. The multiplier Pr2 multiplies the input value  $I_a^*$  by "-1" and outputs a current command value  $I_b^*$  of the "b" phase. The subtractor Def2 receives the current command value  $I_a^*$  and the phase "a" current  
15  $I_{sysa}$  of the detected current value, calculates their difference  $dI1$ , and outputs the result to the current regulator 12a.

Similarly, the subtractor Def1 receives the current command value  $I_b^*$  and the phase "b" current  
20  $I_{sysb}$  of the detected current value, calculates their difference  $dI2$ , and outputs the result to the current regulator 12b.

The voltage amplitude value  $V_{rms}$  is a preset voltage value of the system 2 to which said converter  
25 1-1c is connected and output as a command value to the

multiplier Pr3. Said multiplier Pr3 multiplies the voltage amplitude value  $V_{rms}$  and the phase signal  $Asin$  and outputs a sinusoidal voltage feed-forward command value  $Va^*$  of the amplitude  $V_{rms}$ . When the phase signal

5  $Asin$  is regulated to a sinusoidal wave which follows the "a" phase of the system voltage, the voltage feed-forward command value  $Va^*$  becomes approximately equal to the voltage command value of the "a" phase. The voltage feed-forward command  $Va^*$  is fed to the

10 multiplier Pr4 and to the adder Ad1. The multiplier Pr4 multiplies the input value  $Va^*$  by "-1" and outputs a voltage feed-forward command value  $Vb^*$  of the "b" phase to the adder.

The current regulators 12a and 12b regulate the

15 output voltage values  $V_{ia}$  and  $V_{ib}$  to eliminate the difference of inputs (to a zero). The outputs of the current regulators 12a and 12b are respectively fed to the adders Ad1 and Ad2. The adder Ad1 adds the voltage feed-forward command  $Va^*$  and the output value  $V_{ia}$  and

20 outputs the result  $V_{ao}^*$  to the pulse width modulation calculator PWM (pulse output means). The adder Ad2 adds the voltage feed-forward command  $Vb^*$  and the output value  $V_{ib}$  and outputs the result  $V_{bo}^*$  to the pulse width modulation calculator PWM. The pulse width

25 modulation calculator PWM compares the input values

Vao\* and Vbo\* by a triangular wave and outputs gate pulses  $Gp_0$  for operating the single-phase inverter to the gate circuit of the converter 1-1c.

FIG. 4 is a functional block diagram of the current regulator 10a. Referring to FIG. 4, the subtractor Def3 receives the current command value IREFa and the detected current value IBT, calculates the difference of these inputs IREFa and IBT, and outputs the result to the current regulator 13a. The current regulator 13a regulates an output duty command value Da\* to eliminate this input difference (to a zero) and outputs the value Da\* to the pulse calculator 14a. The pulse calculator 14a compares the input value Da\* by a triangular wave and outputs gate pulses GPa for operating the DC/DC converter 1-1a to the gate circuit of the converter 1-1a.

FIG. 5 is a functional block diagram of the current regulator 10b. Referring to FIG. 5, the subtractor Def4 receives the current command value IREFb and the detected current value IFC, calculates the difference of these inputs IREFb and IFC, and outputs the result to the current regulator 13b.

The current regulator 13b regulates their output duty command value Db\* to eliminate the difference of the input values, and outputs the output value Db\* to

the pulse calculator 14b. The pulse calculator 14b compares the input value  $Db^*$  by a triangular wave and outputs gate pulses  $GPb$  for operating the DC/DC converter 1-1b to the gate circuit of the converter 1-1b.

FIGs. 6 through 10 are functional block diagrams of a power regulator 4. Referring to FIG. 6, the power detector 15 receives the system current  $IL1$  and the system voltage  $VL1$ , calculate a power from the input values  $IL1$  and  $VL1$  and outputs the result (as a calculated receiving power value  $PD$ ) to the power regulator 16 and the load power calculator 17. The detected secondary battery voltage value  $Ea$  is fed to the load power calculator 17 and to the battery controller 18.

The battery controller 18 has a function for calculating the remaining capacity of the secondary battery (for example, calculating the remaining capacity  $Wa$  by a  $Ea-Wa$  relationship of the secondary battery  $Bat$ ) and outputs the remaining capacity value  $Wa$  to the power regulator 16. In FIG. 6, the battery controller 18 receives a voltage only, but it is possible to take in the secondary battery current and calculate the remaining capacity value  $Wa$  from the current integration value.

Referring to FIG. 7, the configuration of the power regulator 16 is explained below. The power regulator 16 receives the calculated receiving power value PD, the receiving power threshold value PD\*, and the calculated remaining battery capacity Wa. The subtractor Def5 in the power regulator 16 receives the receiving power threshold value PD\* and the calculated receiving power value PD, calculates the difference between these input values PD and PD\*, and outputs the result to the integrator 19.

The integrator 19 integrates the differences and outputs the result (as a battery current command value Idbat) to the charge/discharge selector 20. The integrator 19 is equipped with a limiter function to prevent the integrator from overflowing. The limiter range is 0 to a value equivalent to the maximum available current of the secondary battery so that the limiter can work only when the differences are positive (only when the calculated receiving power value PD is greater than the receiving power threshold value PD\*).

The charge/discharge selector discriminator 21 receives the remaining battery capacity Wa, outputs "1" so that the charge/discharge selector 20 may output a charging current command value Icbat when the

remaining battery capacity  $W_a$  is below a preset capacity  $BH$  at which the secondary battery stops discharging, holds the signal "1," and outputs "0" when the remaining battery capacity  $W_a$  becomes equal  
5 to the preset capacity value  $BH$ . This hysteresis to delay output of the "0" signal enables charging.

The quantity of charging can be controlled by the preset capacity value  $BH$ . The value  $BH$  is preferably a full charging capacity in the available range of the  
10 secondary battery capacity or a little smaller than it. In this case, it is possible to quicken a charge-starting point by changing the preset  $BL$  value.

By making the preset values  $BH$  and  $BL$  changeable, the quantity of charging can be controlled according  
15 to charging requirements such as charging at night and small receiving power. The load power calculator 17 in FIG. 6 calculates a load power  $PL$  consumed by the load 3 by Equation 1 and outputs the result (a calculated load power value  $PL$ ) to the filter 22.

20 
$$PL = PD - (IREFa \times Ea + IREFb \times Eb) \dots (\text{Equation 1})$$

The filter calculates a load power value  $PLF$  excluding a sharp change component (or high frequency components) from the load power  $PL$  and outputs it to the power command value calculator 23. The power  
25 command value calculator 23 calculates a power command



value  $P_{out}$  which follows the change of the calculated load power value  $P_L$  and outputs the power command value  $P_{out}$  to the delay adder 24 and to the fuel converter 25.

5           As above described, this invention is characterized by

          a fuel cell system control unit comprising a first converter 1-1c electrically connected to an electric power system 2 through a circuit-breaker means BR1, a  
10       set of fuel cells FC1 connected to the DC circuit of said converter 1-1c through a second converter 1-1b, a secondary battery Bat connected to said DC circuit through a third converter 1-1a, a current detecting means CT4 which detects AC currents from said  
15       converters 1-1c and outputs their detected values, a voltage detecting means PT1 which detects an AC voltage on the power system side of said circuit breaker means BR1 and outputs its detected value, a fuel cell current detecting means which detects a  
20       current from said fuel cell set FC1, a fuel cell voltage detecting means which detects the voltage  $E_b$  of said fuel cell set FC1, a secondary battery current detecting means CT2 which detects a current from said secondary battery Bat, and a secondary battery voltage  
25       detecting means which detects the voltage  $E_a$  of said

secondary battery Bat; wherein said fuel cell system control unit further comprises a receiving current detector IL1 which detects the total of a current flowing through said first converter 1-1c and a  
5 current flowing through an electric load 3 connected in parallel with said first converter 1-1c, a first power calculating means which calculates a receiving power from a receiving current detected by said receiving current detector IL1 and a system voltage  
10 detected by said system voltage detecting means PT1, a second power calculating means which calculates a power from said first converter, and a means which calculates a power consumed by said load 3 from the outputs of said first and second power calculating  
15 means.

FIG. 8 is a functional block diagram of a power command value calculator 23. The power which the fuel cell FC1 can output varies depending upon the quantity of fuel (modified gas) supplied to the fuel cell. For  
20 example, when the valve VV1 for controlling the fuel is regulated stepwise, the power which is output by the fuel cell FC1 also varies stepwise. (The width of the power change step is defined as "dP.") When the valve VV1 is regulated finely, the power which is  
25 output by the fuel cell FC1 varies finely. This

stepwise regulation is explained in detail by way of an example. As shown in FIG. 8, the power command value calculator 23 varies the power command value  $P_{out}$  stepwise so that the power command value  $P_{out}$  may not go over the line  $Ln0$  whose gradient (the ratio of output to input) is 1. In this case, the step height is determined by the output change width  $dP$ . When the difference between the input value and the line  $Ln0$  becomes greater than the change width  $dP$ , the power command value  $P_{out}$  is incremented by the change width  $dP$ . The maximum power command value  $P_{out}$  is limited in advance so that the fuel output capacity may be a maximum  $P_{max}$ .

FIG. 9 shows behaviors of the calculated power value  $PLF$  and the power command value  $P_{out}$ . The power command value  $P_{out}$  of the fuel cell follows the calculated power value  $PLF$  as the load power  $PL$  changes.

The fuel converter 25 of FIG. 6 calculates the opening command  $SVV1$  for the fuel regulating valve  $VV1$  equivalent to the power command value  $P_{out}$  and varies the opening of the fuel regulating valve  $VV1$ . With this, a flow rate of fuel equivalent to the power command value  $P_{out}$  is supplied to the fuel cell. Actually, however, the electric output cannot be

increased immediately when the fuel flow rate is changed because of a delay of fuel flowing through the pipe, a delay in production of modified gas from fuel, and so on. To solve this problem, the delay adder 24  
5 adds a delay time equivalent to the above delays (fuel supply delay in the pipe and delay in hydrogen-rich gas production) to the power command value Pout and outputs a power command value PoutD including a delay time to the current converter 26.

10         The current converter 26 receives the power command value PoutD and the fuel cell voltage Eb, divides the PoutD value by the Eb value to get a current command value IREFb of the fuel cell.

Referring to FIG. 10, the configuration of the  
15 delay adder 24 is explained below.

The delay adder 24 is so designed that the delay element "delay" delays the change of the power command value Pout by a preset time period (equivalent to a delay time between the increase of fuel and power  
20 generation) when the command value Pout increases or adds no delay time when the command value Pout decreases. (Although this example does not add a delay time, it is possible to add a delay time. In this case, the power output from the fuel cell is apt to exceed  
25 the load power and the charging time of the secondary

battery increases.)

Referring to FIG. 11, the operation of the power converter is explained below.

The operation of the load power PL, the calculated  
5 power value PLF, and the power command value PoutD  
(signal adding a rise delay time to the power command  
value Pout) is omitted here. (See the description of  
FIG. 9.) When the receiving power threshold value PD\*  
is set to for example 0 kW, the secondary battery  
10 supplies the difference between PL and Pout. When PL  
is greater than Pout, the secondary battery discharges  
the difference to keep the receiving power at 0 kW.  
Contrarily, when PL is smaller than Pout, the  
secondary battery charges the difference (charged from  
15 the fuel cell) to keep the receiving power at 0 kW.

As above described, this invention is  
characterized by

a fuel cell system control unit comprising a first  
converter 1-1c electrically connected to an electric  
20 power system 2 through a circuit-breaker means BR1, a  
set of fuel cells FC1 connected to the DC circuit of  
said converter 1-1c through a second converter 1-1b, a  
secondary battery Bat connected to said DC circuit  
through a third converter 1-1a, a current detecting  
25 means CT4 which detects AC currents from said

converters 1-1c and outputs their detected values, a voltage detecting means PT1 which detects an AC voltage on the power system side of said circuit breaker means BR1 and outputs its detected value, a  
5 fuel cell current detecting means which detects a current from said fuel cell set FC1, a fuel cell voltage detecting means which detects the voltage Eb of said fuel cell set FC1, a secondary battery current detecting means CT2 which detects a current from said  
10 secondary battery Bat, and a secondary battery voltage detecting means which detects the voltage Ea of said secondary battery Bat; wherein the fuel cell system control unit further comprises a voltage regulating means 7 (voltage controller) which feeds back a DC  
15 voltage value Ed0 detected by said first converter 1-1c and outputs a current command value Isys\* so that the product of the fed-back DC voltage value by the current command value may be equal to the power command value, automatic current regulators 12a and  
20 12b (current regulators) which respectively feed back said detected current value Iinv and outputs voltage command values Vao\* and Vbo\* to make the current equal to said current command value Isys\*, a pulse output means (Pulse width modulation calculator) which  
25 receives said output voltage command value and outputs

pulses GP0 to drive the converter 1-1c, and a control unit which controls charging and discharging of the power system and power according to said voltage command value  $I_{sys}^*$ .

- 5           The fuel cell system control unit further comprises power converters 1-1a, 1-1b, and 1-1c wherein a means for controlling said second converter 1-1b has a current control means 13b (current controller) to make the current command value  $I_{REFb}$
- 10           equal to the current  $I_{FC}$  of the fuel cell and a means for controlling said third converter 1-1a has a current control means 13a to make the current command value  $I_{REF}$  equal to the current  $I_{BT}$  of the secondary battery.
- 15           The fuel cell control system further comprises a receiving current detector CT1 which detects the total of a current flowing through said first converter 1-1c and a current flowing through an electric load 3 connected in parallel with said first
- 20           converter 1-1c,
- a first power calculating means 15 (power controller) which calculates a receiving power from a receiving current  $I_{L1}$  detected by said receiving current detector CT1 and a system voltage  $V_{L1}$  detected
- 25           by said system voltage detecting means PT1,

a second power calculating means 17 (converter controller) which calculates a power from said first converter 1-1c, and

5 a means 4 which calculates a power consumed by said load 3 from the outputs of said first and second power calculating means 15 and 17.

The fuel cell system control unit of this invention detects a receiving power by this configuration and cuts its peaks by the secondary  
10 battery.

The fuel cell system control unit calculates a load power from a detected receiving power and command values of the secondary battery and the power generating apparatus in the controller.

15 The fuel cell system control unit uses the load power for creation of fuel cell command values.

In this configuration, the output of the power generating apparatus is made to follow the low-frequency component in the fluctuation of the load  
20 power.

A time delay before power generation of the fuel cell due to a fuel delay in the pipe, etc. is added when a current command value goes up as the fuel increases.

25 The current control command value is limited to



take out current from the fuel cell.

This invention can detect a receiving power and cuts its peaks by the secondary battery according to it. This can prevent the receiving power from going  
5 over the permissible receiving power value due to the delay of output of the power generating apparatus.

This invention can calculate a load power from a detected receiving power and command values of the secondary battery and the power generating apparatus  
10 in the controller. This can omit current and voltage sensors for the load power.

This invention can use the load power for creation of fuel cell command values. This can separate a power from the secondary battery and make the fuel cell  
15 follow the load power.

Further, this invention can make the output of the power generating apparatus follow the low-frequency component in the fluctuation of the load power. This can downsize the secondary battery as a long great  
20 power from the secondary battery is not required. Furthermore, this invention can prevent a frequent fuel supply change due to a load fluctuation. With this, the fuel cell can use the fuel effectively for power generation and make the whole system high  
25 efficient.

Still further, this invention adds a time delay before power generation of the fuel cell due to a fuel delay in the pipe, etc. is added when a current command value goes up as the fuel increases. This can  
5 make the fuel cell output power after the fuel is supplied to the fuel cell and prevent deterioration of the electrodes.

Finally, this invention limits the current control command value to take out current from the fuel cell.  
10 This can prevent overloading of the fuel cell.